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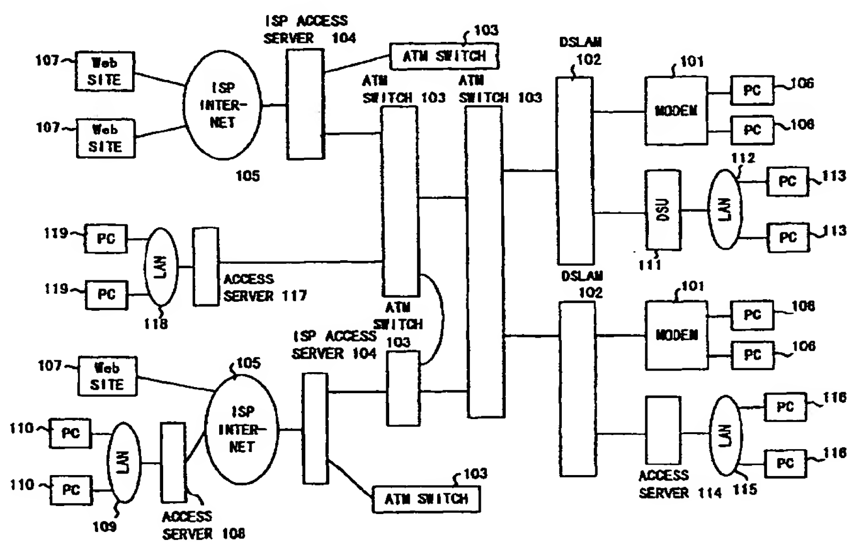
(54) **SVC accessing method for use in ATM-DSLAM (ATM - DSL Access Multiplexer)**

(57) An access server and a DSLAM are continuously connected by a PVC. The access server and the DSLAM manage an unused ATM VC within the PVC while making a communication with an idle VC indication cell which is an OAM cell. The DSLAM allocates the unused ATM VC by communicating with the access server based on a call originating request issued from a modem.



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the Internet backbone 2101 and the access network 2106, which are shown in Fig. 1. Considering this fact and the convenience where an existing copper wire cable can be used while maintaining a telephone service, it is significant that the xDSL line accommodated by the DSLAM is used as an access line to the ATM network or to the Internet.

[0016] In this case, an IP datagram transmitted, for example, from the PC or the LAN possessed by the user 2107 to the Web site 2102, is converted into an ATM cell and is further converted into an XDSL signal by the xDSL modem in the user 2107's home.

[0017] The xDSL signal is transmitted to the copper wire cable which is the subscriber line via the splitter in the user 2107's home, and reaches the accommodation station.

[0018] After the xDSL signal is split from a telephone speech signal by the splitter in the accommodation station, it is received by the DSLAM within the accommodation station.

[0019] The ATM cell received by the DSLAM is multiplexed with an ATM cell received from another subscriber line, and then transmitted to an ATM interface (such as a SONET interface) leading to the access network 2106 configured by the ATM network.

[0020] The ATM cell which has passed through the access network 2106 is received by an access server within the access point 2105. The access server extracts the IP datagram from the received ATM cell.

[0021] The extracted IP datagram is transferred to the Web site 2102 via the Internet backbone 2101.

[0022] To typically implement the connection to the Internet, the user 2107 first makes a point-to-point connection to the access server within the access point 2105 which is the entry to the Internet backbone 2101 by using a protocol referred to as a PPP (Point to Point Protocol). At this time, the user 2107 is assigned a global IP address which is determined according to a protocol referred to as an IP (Internet Protocol) and can be uniquely identified on the Internet, from a DHCP (Dynamic Host Configuration Protocol) server etc. belonging to an access server depending on need. Thereafter, the user 2107 stores the IP datagram including the IP address of an opposing server in a PPP packet by using a global IP address which is originally possessed by the user 2107 or is dynamically assigned, and exchanges the IP datagram with a server at a destination side.

[0023] In the meantime, for example, if two communicating devices make a communication in an ATM network, ATM addresses must be respectively assigned to both of the devices. At the same time, an ATM connection (VC: Virtual Connection/Channel) which can be uniquely identified within the ATM network must be established between the two devices.

[0024] Accordingly, with the technique for integrating the xDSL line, the ATM network, and the Internet, an ATM connection must be established based on the specification of ATM addresses between the xDSL modem within the user 2107 and the access server within the access point 2105 when a PPP session is started, as described above.

[0025] However, since the xDSL technique assumes that a high-speed communication is made at a low cost by directly linking an xDSL mode within a subscriber home and a DSLAM within an accommodation station, there is no concept of connecting/disconnecting an xDSL communication for each communication. Therefore, this technique does not work well with the control for establishing/releasing an ATM connection.

[0026] Accordingly, a dedicated line connection form where the access server within the access point 2105, the DSLAM within the accommodation station, and the xDSL modem in the subscriber home are continuously connected with a PVC (Permanent Virtual Connection/Channel) was conventionally adopted in the network system where the xDSL line, the ATM network, and the Internet are integrated.

[0027] However, the same number of ATM connections as that of users 2107 are required in the above described conventional connection form, although general end users such as home users, etc. are not continuously connected to the Internet. Therefore, the connection resources (more specifically, the number of VPIs/VCIs or the bandwidth used by a switch) within the ATM network are fixedly and wastefully used, which leads to the inability of ATM networks being applied to a large number of subscribers.

[0028] An SVC (Switched Virtual Connection/Channel) which is a connection for each call may be applied to overcome this problem. However, because the connection form of the xDSL communication is assumed to be connectionless as described above, this communication does not work well with a connectionless SVC communication and an effective SVC controlling method does not currently exist.

Summary of the Invention

[0029] The present invention was developed in the above described background, and aims at realizing a connection form where the connection resources within an ATM network can be efficiently used, when an xDSL line is connected to a particular destination such as an access server, etc. via a cell switching network such as an ATM network, etc.

[0030] One mode of the present invention assumes a method with which a subscriber side modem which performs modulation/demodulation with a digital subscriber line method accesses an access server connected to an ATM switch network by using ATM cells transferred with an asynchronous transfer mode method via an accommodation station side modem, which accommodates a digital subscriber line to which the subscriber side modem is connected.

[0031] The access server and the accommodation

switch 103 and an access server 117, etc. are respectively interconnected by SONET interfaces.

[0045] The ISP side access server 104 is connected to an Internet 105 belonging to the corresponding ISP. Web sites 107 or another access server 108 which accommodates a LAN 109 to which PCs 110 are connected is connected to the Internet 105. An IP communication using an IP datagram is made on the Internet 105.

[0046] The DSLAM 102 may be connected with a LAN 112 which accommodates PCs 113, etc. via a DSU (Data Service Unit) 111 in addition to the modem 101. In this case, the DSLAM 102 and the DSU 111 are continuously connected.

[0047] The DSLAM 102 may be connected with an access server 114 which supports an xDSL communication, and the access server 114 may further be connected with a LAN 115 which accommodates PCs 116.

[0048] Additionally, an ATM switch 103 may be connected with an access server 117 to which an in-house LAN 118 which accommodates PCs 119 is connected.

(Communications Protocol Stacks between Respective Devices)

[0049] Fig. 3 shows the communications protocol stacks between respective devices configuring the network shown in Fig. 2.

[0050] Provided first is the explanation about a communication protocol between a PC 106 and a modem 101 by taking as an example the case where data is transferred from the PC 106 to the modem 101 with reference to Figs. 3 through 5. Note that the communications protocol is the same also in the case where data is transferred from the modem 101 to the PC 106, except for the difference that the flow of the data becomes reversed.

[0051] User information (such as TCP (Transfer Control Protocol) segment data, etc.) generated by an application within the PC 106 is stored in a data area of the IP datagram where a public IP address is specified in its header, as shown in Fig. 4(a). The public IP address can be uniquely identified in the Internet space around the world. As will be described later, the IP address assigned to the IP datagram is identified by the ISP side access server 104 (simply referred to as an access server 104 hereinafter), so that the IP datagram is transferred, for example, to a Web site 107 on the Internet 105 shown in Fig. 2.

[0052] Next, the IP datagram is stored in the data area of a PPP packet to which a header and a trailer are added, as shown in Fig. 4(b). After the PPP packet is identified by the modem 101, it is terminated by the access server 104, as will be described later. With this packet, a point-to-point data communication between the PC 106 and the access server 104 can be made via the modem 101.

[0053] The PPP packet is then stored in the data area of the PPP packet generated based on a PPTP (Point to Point Tunneling Protocol) or an L2TP (Layer 2 Tunneling Protocol) as shown in Fig. 4(c). This PPTP (or L2TP) packet is terminated by the modem 101 as will be described later. The PPTP (or the L2TP) is a protocol for relaying a PPP packet to a second device whose line is connected to a first device so that the first device which is not directly connected to a line communicates with a PPP connection destination which is reachable via a line. In this case, the PPTP (or L2TP) packet including the PPP packet is made to pass through a logical communication channel between the first and second devices. In the preferred embodiment of the present invention, the PPTP (or L2TP) packet generated by the PC 106 which is not directly connected to an xDSL line is transmitted to the modem 101 through the tunnel of a private IP communication channel to be described next. The modem 101 extracts the PPP packet from the PPTP (or L2TP) packet, and transmits the extracted packet to the xDSL line leading to the access server 104 which is a PPP connection destination. The reason why the PPP packet is included in the PPTP (or L2TP) packet is to allow a plurality of sessions to be processed without inconsistency. To implement this, an identifier for identifying each session or a sequence number, etc. is stored in the header of the PPTP (or L2TP) packet.

[0054] Next, in the PC 106, the PPTP (or L2TP) packet is stored in the data area of a UDP datagram generated based on a UDP (User Datagram Protocol) as shown in Fig. 4(d). The UDP datagram is terminated by the modem 101 as will be described later. A port number for identifying a PPTP (or L2TP) driver application which processes a PPTP (or L2TP) packet is assigned to the header of the UDP datagram.

[0055] Additionally, in the PC 106, the UDP datagram is stored in the data area of the IP datagram where an IP address in private IP addresses which assigned for the local network between the PC 106 and the modem 101 is assigned to its header, as shown in Fig. 4(e). Even if a user who possesses the modem 101 can assign, for example, only one public IP address with the private IP datagram, the device (PC 106) within the LAN, to which the modem 101 is connected, can make an intercommunication in a local address space.

[0056] Lastly, in the PC 106, the private IP datagram is stored in the data area of an Ethernet frame generated based on an MAC (Media Access Control) protocol as shown in Fig. 4(f), and is transmitted to a 10Base-T interface. The physical address of either of the devices between which a communication is made is specified in the header of the Ethernet frame. With this frame, the control for preventing a frame collision in the 10Base-T interface is performed.

[0057] After the Ethernet frame transmitted to the 10Base-T interface in the above described way is received by the modem 101, the private IP datagram is extracted from its data area as shown in Figs. 5(e) and 5(d).

which assigned for the local network between the PC 106 and the modem 101 by communicating with a BootP client 714 within the PC 106, when the PC 106 is connected to the 10Base-T hub 701 and is booted up.

[0082] An IP tunnel/ATM VC negotiator 707 performs conversion between the IP tunnel link information according to the PPTP (or the L2TP) and the ATM VC (ATM Virtual Connection) information which is the information about an ATM connection, and notifies a Q.2931 processor 709 or the PPTP controller 705 of the converted information.

[0083] Additionally, the IP tunnel/ATM VC negotiator 707 receives a transmission speed requested by the controller 705, when the PPTP controller 705 connected to the IP tunnel/ATM VC negotiator 707 detects the occurrence of the IP tunnel request issued from the PC 106. The IP tunnel/ATM VC negotiator 707 then arbitrates whether or not to accept the requested transfer speed by making an inquiry to a resource manager 708 which manages the bandwidth of an xDSL line, and feeds back the transfer speed determined based on the result of the arbitration to the PPTP controller 705.

[0084] The Q.2931 processor 709 performs the control of connecting/disconnecting an ATM VC between the DSLAM 102 and the modem 101 itself according to the ITU-T Q.2931 signaling procedures. When an ATM VC request is issued, a VPI (Virtual Path Identifier)/VCI (Virtual Channel Identifier) for an ATM VC is assigned from the DSLAM 102. Therefore, the Q.2931 processor 709 sets the assigned VPI/VCI to the SAR (Segmentation And Reassembly unit) 710.

[0085] The SAR 710 assembles an ATM cell from the PPP packet passed from the PPTP controller 705 to which the SAR 710 is connected in the order of Figs. 6(a), to 6(c), assigns the VPI/VCI notified from the Q.2931 processor 709 to the header of the assembled ATM cell, and passes the ATM cell to a cell multiplexing circuit 711.

[0086] Conversely, the SAR 710 assembles a PPP packet from the ATM cell passed form the cell multiplexing circuit 711 in the order of Figs. 6(c) to 6(a), and passes the assembled packet to the PPTP controller 705 to which the corresponding SAR 710 is connected.

[0087] The cell multiplexing circuit 711 multiplexes the ATM cells passed from a plurality of SARs 710, and passes the multiplexed cell to an xDSL driver 712.

[0088] Conversely, the cell multiplexing circuit 711 demultiplexes each ATM cell corresponding to each of the plurality of SARs 710 from the ATM cell group passed from the xDSL driver 712, and passes the demultiplexed ATM cell to each corresponding SAR 710.

[0089] The xDSL driver 712 modulates the multiplexed signal passed from the cell multiplexing circuit 711, and transmits the resultant xDSL signal to a subscriber line which is an xDSL line.

[0090] Conversely, the xDSL driver 712 receives the xDSL signal from the subscriber line, demodulates the xDSL signal, and passes the resultant multiplexed signal to the cell multiplexing circuit 711.

[0091] A rate controller 713 detects the bandwidth used by the xDSL line and controls the bandwidth for the xDSL line. The bandwidth control state is managed by the resource manager 708.

〈Configuration of the DSLAM 102〉

[0092] Fig. 9 shows the configuration of the DSLAM 102 illustrated in Fig. 2.

[0093] As a capability which particularly relates to the present invention, a frequency detector 802 detects an upstream having a predetermined frequency on a subscriber line which is an xDSL line via a hybrid circuit 801 to which the frequency detector 802 is connected. When the frequency detector 802 detects this upstream, a power controller 803 connected to the frequency detector 802 powers up an xDSL driver 804 and an SVC Cont. 807, which are connected to the power controller 803. As a result, a waste of electric power can be prevented when no communication is made.

[0094] The DSLAM 102 comprises a plurality of ports, each of which is configured by the respective circuits 801 through 805 and 807 through 809 in correspondence with each subscriber line which is an xDSL line.

[0095] In each of the plurality of ports, the xDSL driver 804 extracts an ATM cell by demodulating the xDSL signal received from the hybrid circuit 801 to which the xDSL driver 804 and a subscriber line is connected, and transfers the extracted ATM cell to an ATR 809 via a UPC (Usage Parameter Controller) 808.

[0096] Conversely, the xDSL driver 804 generates an xDSL signal by modulating the ATM cell transmitted from the ATR 809 via the UPC 808, and transmits the generated signal to the subscriber line via the hybrid circuit 801 to which the xDSL driver 804 is connected.

[0097] The rate controller 805 detects the bandwidth used by the xDSL line and controls the bandwidth for the xDSL line via the xDSL driver 804. The bandwidth control state is managed by a resource manager 806. The resource manager 806 also manages the use state of each ATM VC bandwidth by monitoring each buffer within an ATM matrix 810.

[0098] The UPC 808 performs usage parameter control for an ATM cell. Since this control does not particularly relate to the present invention, its details are omitted.

[0099] An SVC Cont. (SVC controller) 807 is a component which particularly relates to the present invention, and comprehensively controls the connection/disconnection of an ATM VC within the PVC (to be described later) established between the access server 104 and the DSLAM 102 itself. Its details will be described later.

[0100] An ATR (Address Translator) 809 performs a mutual rewrite operation between the VPI/VCI of the header of the ATM cell input/output to/from the ATM

cell from the IP datagram passed from the IP router 904 in the order of Figs. 7(a) to 7(d), and passes the assembled cell to the Con.Mgr. 902 to which the SAR 903 is connected.

[0116] The IP router 904 routes the IP datagram by identifying the public IP address specified in the header of the IP datagram passed from the SAR 903, converts the IP datagram into the physical frame format of the output side line, and transmits it to the Internet 105.

[0117] A DHCP (Dynamic Host Configuration Protocol) server 905 assigns an IP address to a PC 106 with DHCP procedures, when it begins to make a PPP communication with the PC 106.

⟨ Details of Line Connection Procedures ⟩

[0118] Provided below is the explanation about the details of the line connection procedures implemented in the preferred embodiment of the present invention, which has the above described configuration.

[0119] The start-up operations of an xDSL line when the modem 101 is powered up were described earlier.

[0120] Namely, the modem 101 transmits an upstream having a predetermined frequency to the DSLAM 102 via the xDSL driver 712 when power is turned on.

[0121] The frequency detector 802 of the port which accommodates the subscriber line connected to the modem 101 and is included in the DSLAM 102 detects an upstream having a predetermined frequency on the subscriber line via the hybrid circuit 801 to which the frequency detector 802 is connected. When the frequency detector 802 detects this upstream, the power controller 803 connected to the frequency detector 802 powers up the xDSL driver 804 and the SVC Cont. 807, which are connected to the power controller 803. As a result, a waste of electric power can be prevented when no communication is made.

[0122] The frequency detector 802 continues to monitor the upstream having the predetermined frequency on the subscriber line via the hybrid circuit 801 to which the frequency detector 802 is connected even after the corresponding xDSL line is started up.

[0123] If the frequency detector 802 detects a discontinuity of the upstream, it determines that the modem 101 is powered down. Then, the power controller 803 connected to the frequency detector 802 powers down the xDSL driver 804 and the SVC Cont. 807, which are connected to the power controller 803. As a result, a continuous waste of electric power can be prevented.

[0124] Provided next is the explanation about the details of the line connection procedures implemented in the preferred embodiment of the present invention.

[0125] In the preferred embodiment of the present invention, the SVC Cont.807 within each port receives an idle VC indication cell which is an OAM cell via the ATR 809 and the ATM matrix 810, to which the SVC Cont. 807 is connected, within the DSLAM 102 shown in Fig. 9.

[0126] The idle VC indication cell is transmitted by the Con.Mgr. 902 within the access server 104, which is shown in Fig. 10. The Con.Mgr. 902 broadcasts to all of the devices within the ATM network the VPI/VCI of an ATM VC which is unused in the range of the ATM VC belonging to the PVC that the Con.Mgr. 902 itself possesses via the SONET interface circuit 901 as the idle VC indication cell, at regular time intervals (such as at five-minute intervals).

[0127] Fig. 11 shows the data structure of an OAM cell which can form the idle VC indication cell.

[0128] Because the OAM cell is broadcast within an ATM network, the value of the VPI/VCI included in a cell header may be arbitrary (it is ignored). Additionally, the value "111" which instructs reference to inside of a payload is assigned as a payload type.

[0129] The payload of the OAM cell stores an AAL5 (ATM Adaptation Layer 5) protocol data unit.

[0130] The value "00000001" indicating the idle VC indication cell is assigned to the first octet as a cell type identifier.

[0131] The VPI/VCI indicating an ATM VC that the Con.Mgr. 902 does not currently use is particularly stored in an information field as a feature of the idle VC indication cell.

[0132] The idle VC indication cell is received by each SVC Cont. 807 from the ATM switch 103 (shown in Fig. 2) via the SONET interface circuit 811, the ATM matrix 810, and each ATR 809, which are included in the DSLAM 102 shown in Fig. 9.

[0133] Upon receipt of the idle VC indication cell, the SVC Cont. 807 extracts the VPI/VCI of the idle ATM VC stored in the information field of the cell, and registers the extracted VPI/VCI to a nominated VC map possessed by the SVC Cont. 807.

[0134] The nominated VC map stores not only the information about an idle ATM VC but also the information about the ATM VC used by the port to which the map itself currently belongs.

[0135] Fig. 12 shows the data structure of the nominated VC map.

[0136] This map stores, for each ATM VC, the port number (NW Port #) of the SONET interface circuit 811 of the DSLAM 102 to which an ATM VC belongs, an STS channel number (STS CH#) configuring the SONET interface at which the SONET interface circuit 811 terminates, the VPI (VPI #)/VCI (VCI #) of the ATM VC, an ATM address of the access server 104 to which the ATM VC belongs, an identifier (ISP ID) of the ISP (Internet Service Provider) that manages the access server 104, and the current use status (Status) of the ATM VC. A plurality of PCs 106 can be connected to the subscriber line accommodated by the port to which this map belongs via the modem 101, and each of the PCs 106 can individually establish a PPP session with the access server 104. Therefore, one ATM address corresponding to one access server 104 may be assigned to the entries of a plurality of ATM VCs in the above

call established on an analog channel, while "2" is assigned to the call established on a digital channel. "3" is assigned to a call established on whichever channel. "Framing Type" is assigned with a PPP frame type. "1" is assigned for a call using asynchronous framing, while "2" is assigned for a call using synchronous framing. "Packet Recv. Window Size" is assigned with the number of received data packets that the PNS 702 buffers for this session. "Packet Processing Delay" is assigned with the duration of a packet processing delay extension of the data to be transmitted from the PAC 703 to the PNS 702 in units of one-tenth of a second. "Phone Number Length" is assigned with the number of digits of a telephone number in a "Phone Number" field. "Phone Number" and "Subaddress" are assigned with the ATM address of the access server 104.

[0151] Upon receipt of the above described outgoing call request from the PC 106, the PPTP controller 705 (shown in Fig. 8) which corresponds to the above described call and is included in the PAC 703 within the modem 101 passes to the Q.2931 processor 709 the "Phone Number"and the "Subaddress" of the access server 104, which are extracted from the outgoing call request, and passes to the IP tunnel ATM VC negotiator 707 the "Minimum BPS" and the "Maximum BPS", which are extracted from the request.

[0152] The IP tunnel/ATM VC negotiator 707 shown in Fig. 8 performs the following control operations in order to prevent a congestion occurring on an xDSL line which is UBR (Unspecified Bit Rate) controlled. That is, the IP tunnel/ATM VC negotiator 707 converts the minimum BPS and the maximum BPS that the above described IP tunnel request requires into a minimum cell rate and a maximum cell rate, respectively, which are parameters of an ATM VC, and compares the converted rates with the bandwidth of the xDSL line and the currently unused bandwidth, which are received from the resource manager 708. As a result of the comparison, if the values of the IP tunnel request are unsuitable, the IP tunnel/ATM VC negotiator 707 requests the PPTP controller 705 to change these values.

[0153] When the "Phone Number" and the "Subaddress" of the access server 104 are passed from the PPTP controller 705, the Q.2931 processor 709 shown in Fig. 8 issues to the DSLAM 102 the ATM VC request where the ATM address of the access server 104 is specified according to the ITU-T Q.2931 signaling procedures (S4 of Fig. 13 or Fig. 14).

[0154] This ATM VC request is converted into an ATM cell for UNI (User Network Interface) signaling in the SAR 710 shown in Fig. 8, and is transmitted to a subscriber line which is an xDSL line via the cell multiplexing circuit 711 and the xDSL driver 712.

[0155] In the DSLAM 102 shown in Fig. 9, upon receipt of the above described ATM VC request via the hybrid circuit 801, the xDSL driver 804, the UPC 808, and the ATR 809, the SVC Cont. 807 searches for an idle VC with the following procedures.

[0156] First of all, the SVC Cont. 809 identifies from the ATM VC request the ATM address of the access server 104 which is the connection destination.

[0157] The SVC Cont. 807 then searches the ATM VC group including the ATM address of the access server 104 in the nominated VC map (refer to Fig. 12), and extracts the entry of an ATM VC whose current use status is unoccupied, that is, an idle ATM VC from the searched group.

[0158] When the SVC Cont. 807 successfully extracts the entry of the idle ATM VC, it confirms that the VPI/VCI assigned to the extracted entry is not used by communicating with the Con.Mgr. 902 within the access server 104 which is the connection destination.

[0159] Specifically, the SVC Cont. 87 transmits a connection confirm cell which is an OAM cell (S6 of Fig. 13). This OAM cell has the above described data structure shown in Fig. 11. The value "00000002" indicating the connection confirm cell is assigned as the cell type identifier within the payload. Additionally, the ATM address of the access server 104 which is the connection destination, the VPI/VCI of the idle ATM VC, the ATM address of the DSLAM 102, and the port number of the SVC Cont. 807 are stored in the information field.

[0160] The above described connection confirm cell is input from the SVC Cont. 807 to the ATM matrix 810 via the ATR 809, copied in the ATM matrix 810, and broadcast from all of the SONET interface circuits 811 as an OAM cell, in Fig. 9.

[0161] When the OAM cell reaches the Con.Mgr 902 (refer to Fig. 10) within the access server 104 which is the connection destination, the Con.Mgr. 902 identifies that this OAM cell is the connection confirm cell addressed to the Con.Mgr. 902 itself by recognizing the cell type identifier stored in the payload of the OAM cell and the ATM address of its own stored in the information field within the payload.

[0162] The Con.Mgr. 902 then determines whether or not the VPI/VCI stored in the information field within the payload of that connection confirm cell are not currently used (S7 of Fig. 13).

[0163] If the Con.Mgr. 902 determines that the VPI/VCI are currently unused, it transmits a connection confirm reply cell which is an OAM cell (S8 of Fig. 13). This OAM cell has the above described data structure shown in Fig. 11, and the value "00000003" indicating the connection confirm reply cell is assigned as the cell type identifier within the payload. The contents of the information field of the above described connection confirm cell are stored in the information field unchanged.

[0164] This connection confirm reply cell is broadcast as the OAM cell from the Con.Mgr. 902 via the SONET interface circuit 901 in Fig. 10 (S8 of Fig. 13).

[0165] When this OAM cell reaches the DSLAM 102 which is the connection destination, it is transferred from the SONET interface circuit 811 to the ATM matrix 810, copied, and broadcast to the ATRs 809 within all of the ports shown in Fig. 9.

[0184] At first, the SVC Cont. 807 within the DSLAM 102 receives a call terminating request conforming to the Q.2931 signaling procedures from an opposing modem 101.

[0185] The SVC Cont. 807 cancels the mapping of the corresponding VPI/VCI in the ATR 809 according to the call terminating request.

[0186] Additionally, the SVC Cont. 807 restores the use status of the entry corresponding to the VPI/VCI to the unoccupied status in the nominated VC map on a predetermined cycle.

[0187] Furthermore, the SVC Cont. 807 transmits a connection release cell which is an OAM cell. This OAM cell has the above described data structure shown in Fig. 11. The value "00000005" indicating the connection confirm cell is assigned as the cell type identifier of the payload. The ATM address of the access server 104 which is a connection destination, the VPI/VCI of the ATM VC corresponding to the call terminating request, the ATM address of the DSLAM 102, and the port number of the SVC Cont. 807 are stored in the information field.

[0188] The above described connection release cell is input from the SVC Cont. 807 to the ATM matrix 810 via the ATR 809, copied, and broadcast as the OAM cell from all of the SONET interface circuits 811, in Fig. 8.

[0189] When the OAM cell reaches the Con.Mgr. 902 (refer to Fig. 10) within the access server 104 which is the connection destination, the Con.Mgr. 902 identifies that this OAM cell is a connection release cell addressed to the Con.Mgr. 902 itself by recognizing the cell type identifier stored in the payload of the OAM cell and its own ATM address stored in the information field within the payload.

[0190] The Con.Mgr. 902 then resumes the transmission of the idle VC indication cell for the VPI/VCI stored in the information field within the payload of the connection release cell.

⟨Call Termination Process Due to Power-Off of the Modem 101⟩

[0191] For example, if the power of the modem 101 is shut off, an xDSL line is terminated from a subscriber side without the issuance of the call terminating request. If this state is left unattended, this call will remain without being released.

[0192] Therefore, according to the present invention, when the frequency detector 802 detects the discontinuity of an upstream on a subscriber line after an xDSL line is started up, the power controller 803 connected to the frequency detector 802 can be configured to perform the above described call termination process for the SVC Cont. 807 immediately before the xDSL driver 804 and the SVC Cont. 807, which are connected to the power controller 803, are powered down.

⟨Call Termination Process Due to an IP Tunnel Disconnection⟩

[0193] For example, if the power of the PC 106 is shut off, a line is terminated without the termination of an IP tunnel. If this state is left unattended, this call remains without being released as long as the power of the modem 101 is ON.

[0194] Therefore, according to the present invention, it can be configured that the PPTP controller 705 detects the disconnection of an IP tunnel, for example, by detecting the discontinuity of an echo message based on the PPTP, and the Q.2931 processor 709 issues a call terminating request when the disconnection is detected, in the modem 101 shown in Fig. 8.

⟨Prevention of Improper Operations for Establishing an ATM VC Performed by the SVC Cont. 807 and the Con. Mgr. 902⟩

[0195] According to the above described preferred embodiment of the present invention, the idle VC indication cell is configured to be transmitted at regular time intervals (such as at 5-minute intervals) from the Con.Mgr. 902 in order to prevent network resources from being wasted, by utilizing transmission of a cell depending on need.

[0196] However, the idle VC indication cell may be configured to be continuously transmitted as a method for avoiding a collision. In this case, there is no need to perform the confirmation procedure using a connection confirm cell and a connection confirm reply cell.

⟨Incorporating the OAM Cell Termination Capability into a Network Interface Device⟩

[0197] If DSLAMs 102 are connected as a ring, an OAM cell must be configured not to return to an original DSLAM 102.

[0198] In this case, the OAM cell termination capability may be incorporated into a network interface device such as a SONET interface circuit, etc. as an option.

⟨Method for Automatically setting a Nominated VC Map⟩

[0199] The SVC Cont. 807 can extract the ATM address of the ISP to which an idle ATM VC is allocated, by storing the ATM address of the access server 104 that transmitted an idle indication cell in the payload of the cell, and can add the nominated VC map of the SVC Cont. 807 itself based on this data.

Claims

1. An SVC accessing method for use in an ATM-DSLAM, with which a subscriber side terminating device (106, 113, 116) accesses an access server

originating request issued from the subscriber side modem, in the accommodation station modem.

10. The SVC accessing method according to claim 9, further comprising the step of:

storing identification information of the access server along with information about the unused virtual connection in the management and maintenance broadcast cell.

11. The SVC accessing method according to claim 9, further comprising the step of:

selectively running a capability for terminating the management and maintenance broadcast cell input from a network side in an accommodation station side network interface.

12. The SVC accessing method according to claim 6, further comprising the step of:

releasing a virtual connection under a communication by communicating with the access server with a management and maintenance broadcast cell based on a call terminating request issued from the subscriber side modem, in the accommodation station side modem.

13. A modem connecting method with which a subscriber side modem (101) which performs modulation/demodulation with a digital subscriber line method accesses an access server (104, 117) connected to an ATM switch network (103) by using an ATM cell transferred with an asynchronous transfer mode method via an accommodation station side modem (102) accommodating a digital subscriber line to which the subscriber side modem (101) is connected, comprising the steps of:

starting a transmission of an upstream having a predetermined frequency when the subscriber side modem starts its operation, in the subscriber side modem; and
starting an operation of the accommodation station side modem when an upstream having a predetermined frequency on the digital subscriber line on the accommodation station side is detected.

14. The modem connecting method according to claim 13, further comprising the steps of:

monitoring the upstream having the predetermined frequency on the digital subscriber line on the accommodation station side after the operation of the accommodation station side modem is started; and
stopping the operation of the accommodation station side modem when the upstream becomes discontinuous.

15. The modem connecting method according to claim 14, further comprising the step of:

performing a call termination process in the accommodation station side modem for a communication process performed by using the accommodation station side modem and the subscriber side modem immediately before the operation of the accommodation station side modem is stopped.

16. The modem connecting method according to claim 13, further comprising the step of:

performing a call termination process in the subscriber side modem for a communication process performed by using the accommodation station side modem and the subscriber side modem, when a communication signal from a terminal connected to the subscriber side modem is detected to be discontinuous.

17. An ATM-DSLAM device, which is an accommodation station side modem (102), for use in a system where a subscriber side modem (101) performing modulation/demodulation with a digital subscriber line method accesses an access server (104, 117) connected to an ATM switch network (103) by using an ATM cell transferred with an asynchronous transfer mode method via the accommodation station side modem (102) accommodating a digital subscriber line to which the subscriber side modem (101) is connected, comprising:

a connecting device for making a continuous connection with the access server by using a permanent virtual connection;
a connection managing device for managing an unused virtual connection within the permanent virtual connection; and
a connection allocating device for allocating an unused virtual connection to the subscriber side modem by communicating with the access server based on a call originating request issued from the subscriber side modem.

18. The ATM-DSLAM device according to claim 17, wherein said connection managing device manages an unused virtual connection within the permanent virtual connection while exchanging with the access server information about the unused virtual connection by using a management and main-

when said upstream detecting device detects the discontinuity of the upstream.

28. The ATM-DSLAM device according to claim 27, wherein said controlling device performs a call termination process for a communication process corresponding to the subscriber side modem connected to the digital subscriber line immediately before the operation of each communicating device included in the accommodation station side modem corresponding to the digital subscriber line on which the discontinuity of the upstream is detected.

29. A subscriber side modem (101) for use in a system where the subscriber side modem (101) performing modulation/demodulation with a digital subscriber line method accesses an access server (104, 117) connected to an ATM switch network (103) by using an ATM cell transferred with an asynchronous transfer mode method via an accommodation station side modem (102) accommodating a digital subscriber line to which the subscriber side modem (101) is connected, comprising:

an upstream transmitting device for starting a transmission of an upstream having a predetermined frequency when the subscriber side modem starts its operation.

30. The subscriber side modem according to claim 29, further comprising:

a call terminating request issuing device for issuing a call termination request to the accommodation station side modem when discontinuity of a communication signal from a terminal connected to the subscriber side modem itself is detected.

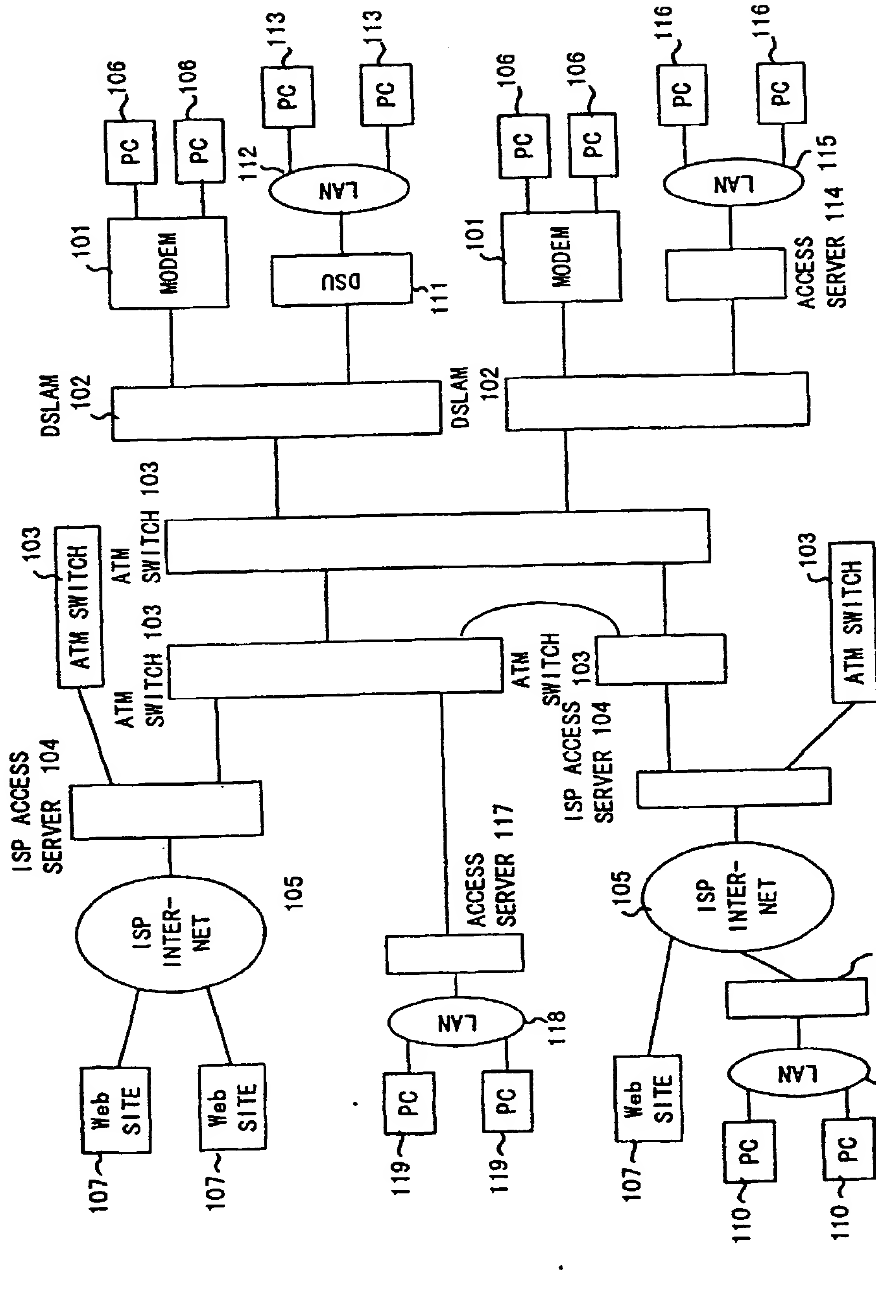
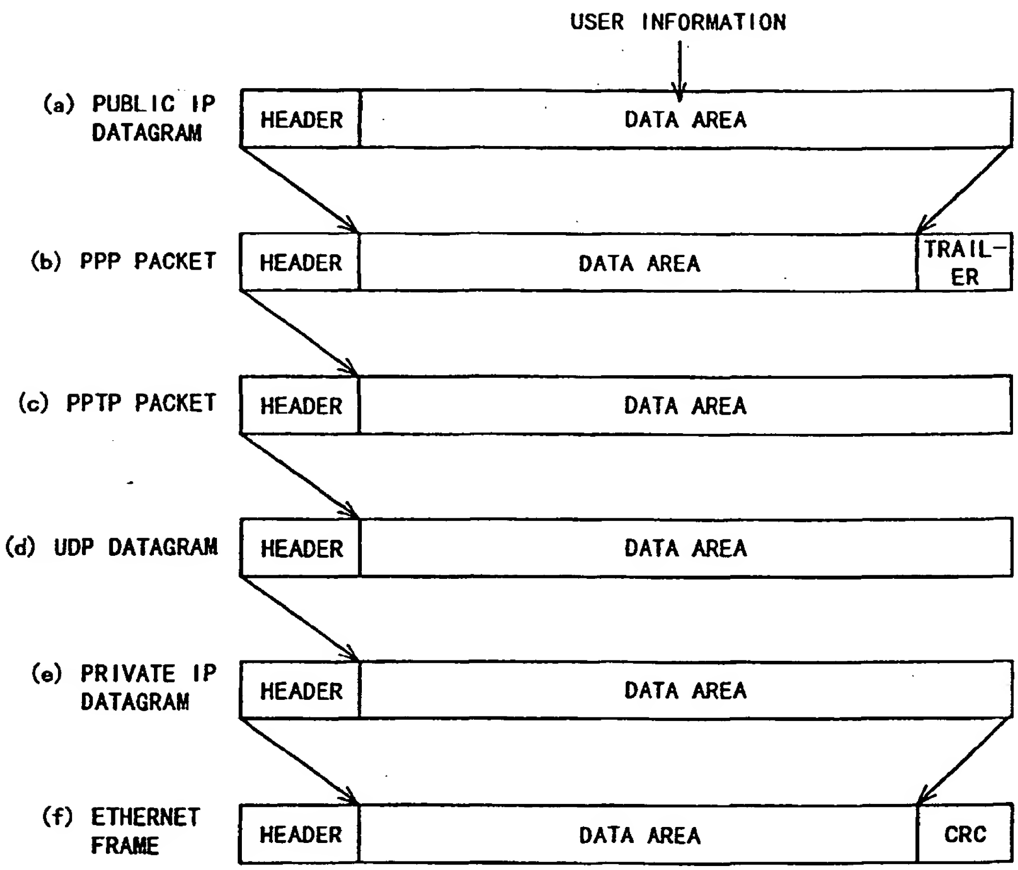

PC
MODEM
DSU
LAN
ACCESS SERVER 114
DSLAM 102
ATM SWITCH 103
ATM SWITCH
ISP ACCESS SERVER 104
ISP INTER-NET
ACCESS SERVER 117
ACCESS SERVER 108
Web SITE
101
106
111
112
113
115
116
105
107
109
110
118
119

FIG. 2


USER INFORMATION
(a) PUBLIC IP DATAGRAM
HEADER
DATA AREA
(b) PPP PACKET
HEADER
DATA AREA
TRAIL-ER
(c) PPTP PACKET
HEADER
DATA AREA
(d) UDP DATAGRAM
HEADER
DATA AREA
(e) PRIVATE IP DATAGRAM
HEADER
DATA AREA
(f) ETHERNET FRAME
HEADER
DATA AREA
CRC

F I G. 4

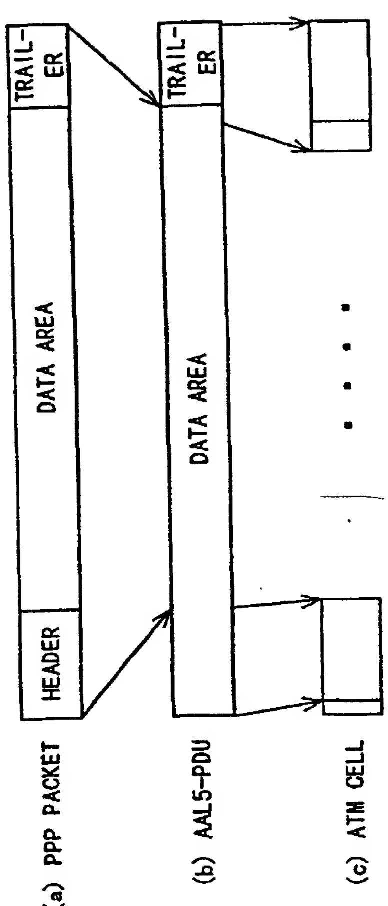
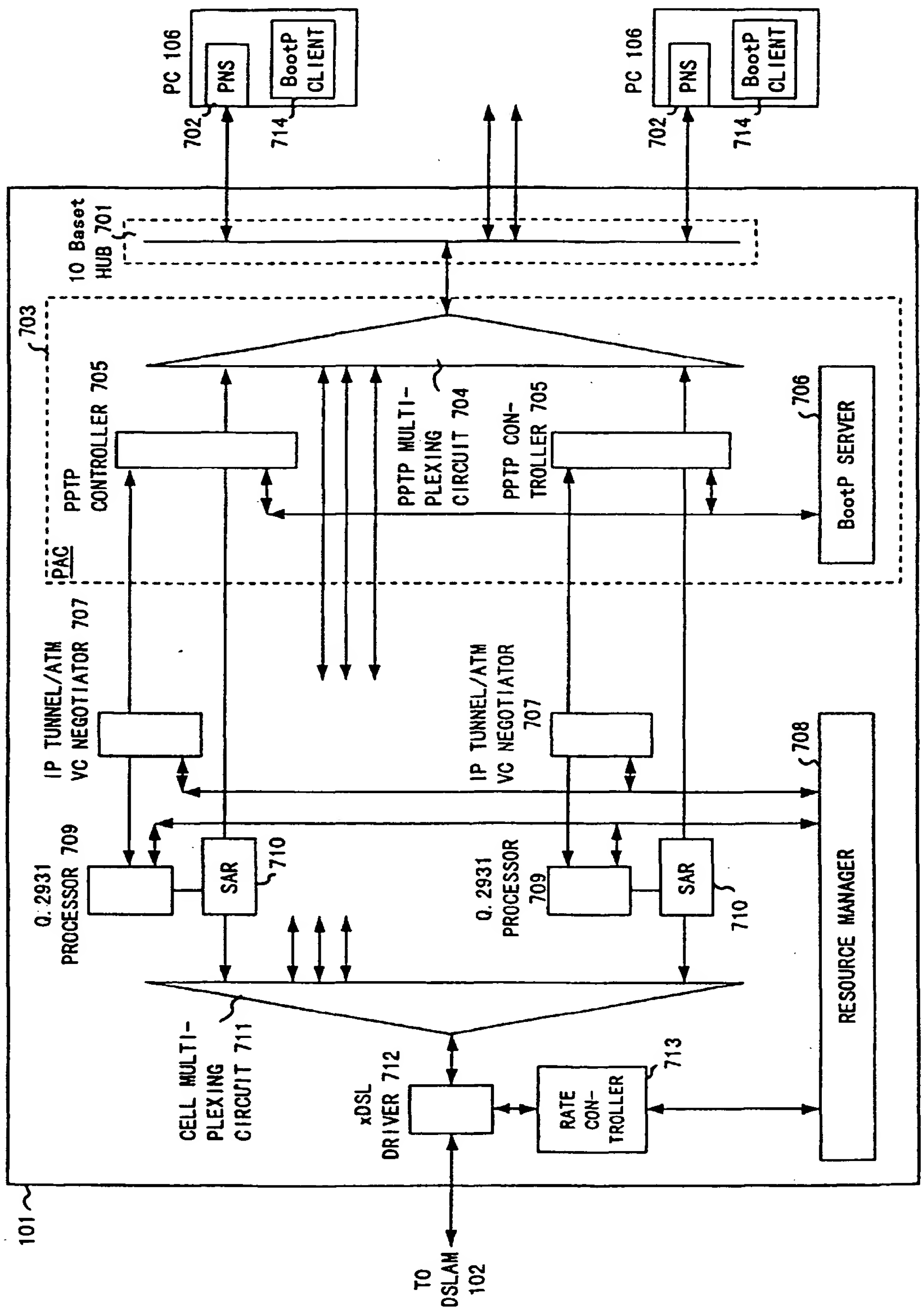

(a) PPP PACKET
HEADER
DATA AREA
TRAIL-ER
(b) AAL5-PDU
DATA AREA
TRAIL-ER
(c) ATM CELL

FIG. 6


PC 106
PNS
BootP CLIENT
702
714
PC 106
PNS
BootP CLIENT
702
714
10 Baset HUB 701
703
PAC
PPTP CONTROLLER 705
PPTP MULTI-PLEXING CIRCUIT 704
PPTP CON-TROLLER 705
706
BootP SERVER
IP TUNNEL/ATM VC NEGOTIATOR 707
IP TUNNEL/ATM VC NEGOTIATOR 707
708
Q. 2931 PROCESSOR 709
SAR
710
Q. 2931 PROCESSOR 709
SAR
710
RESOURCE MANAGER
CELL MULTI-PLEXING CIRCUIT 711
xDSL DRIVER 712
RATE CON-TROLLER
713
101
TO DSLAM 102

F I G. 8

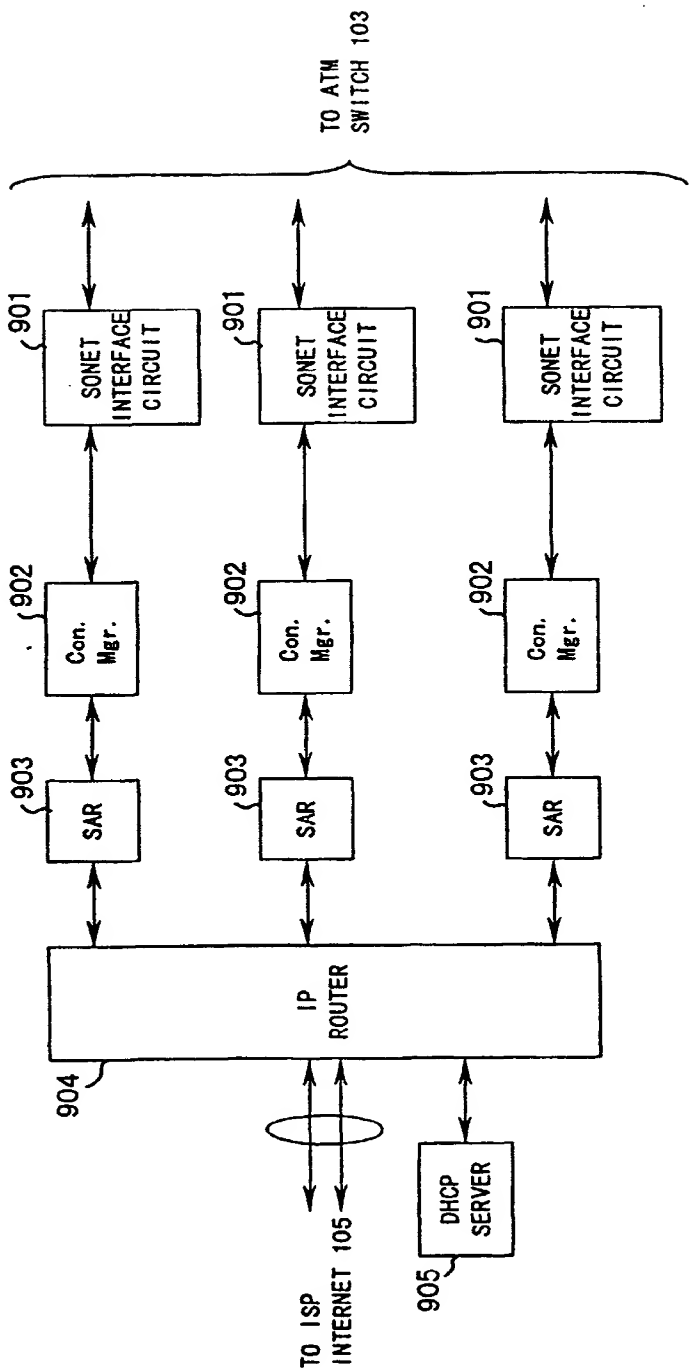
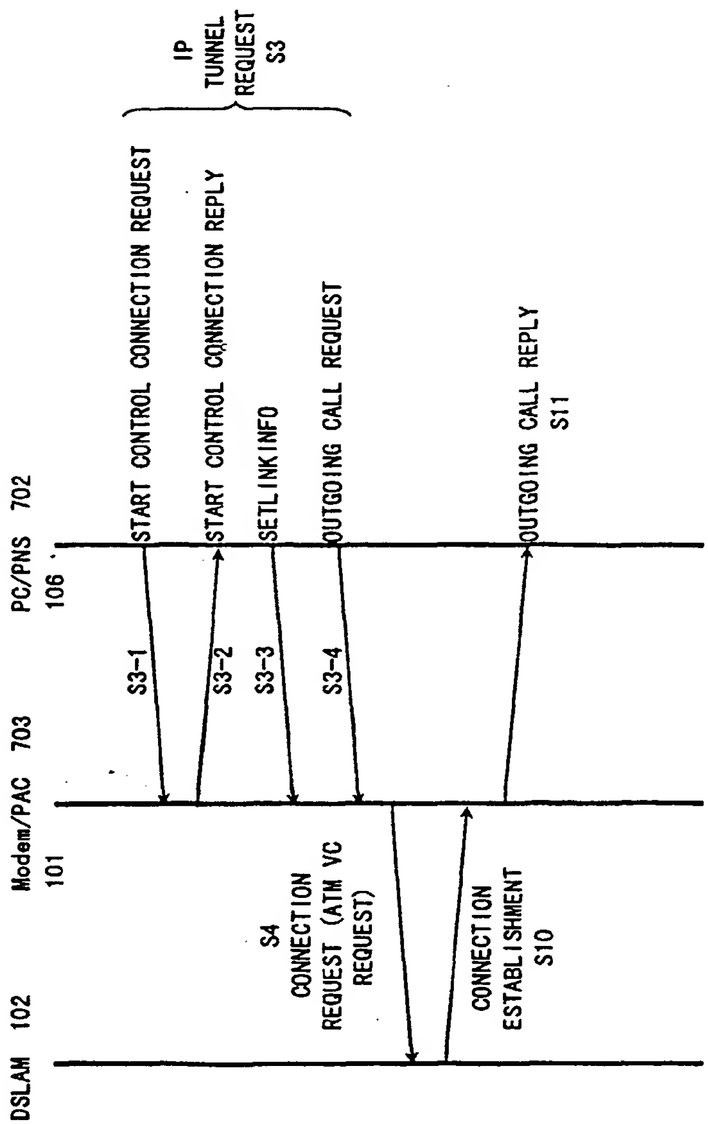


FIG. 10 (ACCESS SERVER)

	ATM VC ID						
#	NW Port#	STS CH#	VPI#	VCI#	ATM Address	ISP ID	Status
1							
2							
3							
100							

FIG. 12



DSLAM 102
Modem/PAC 703
101
PC/PNS 702
106
START CONTROL CONNECTION REQUEST
START CONTROL CONNECTION REPLY
SETLINKINFO
OUTGOING CALL REQUEST
IP
TUNNEL
REQUEST
S3
S3-1
S3-2
S3-3
S3-4
S4
CONNECTION
REQUEST (ATM VC
REQUEST)
CONNECTION
ESTABLISHMENT
S10
OUTGOING CALL REPLY
S11

FIG. 14

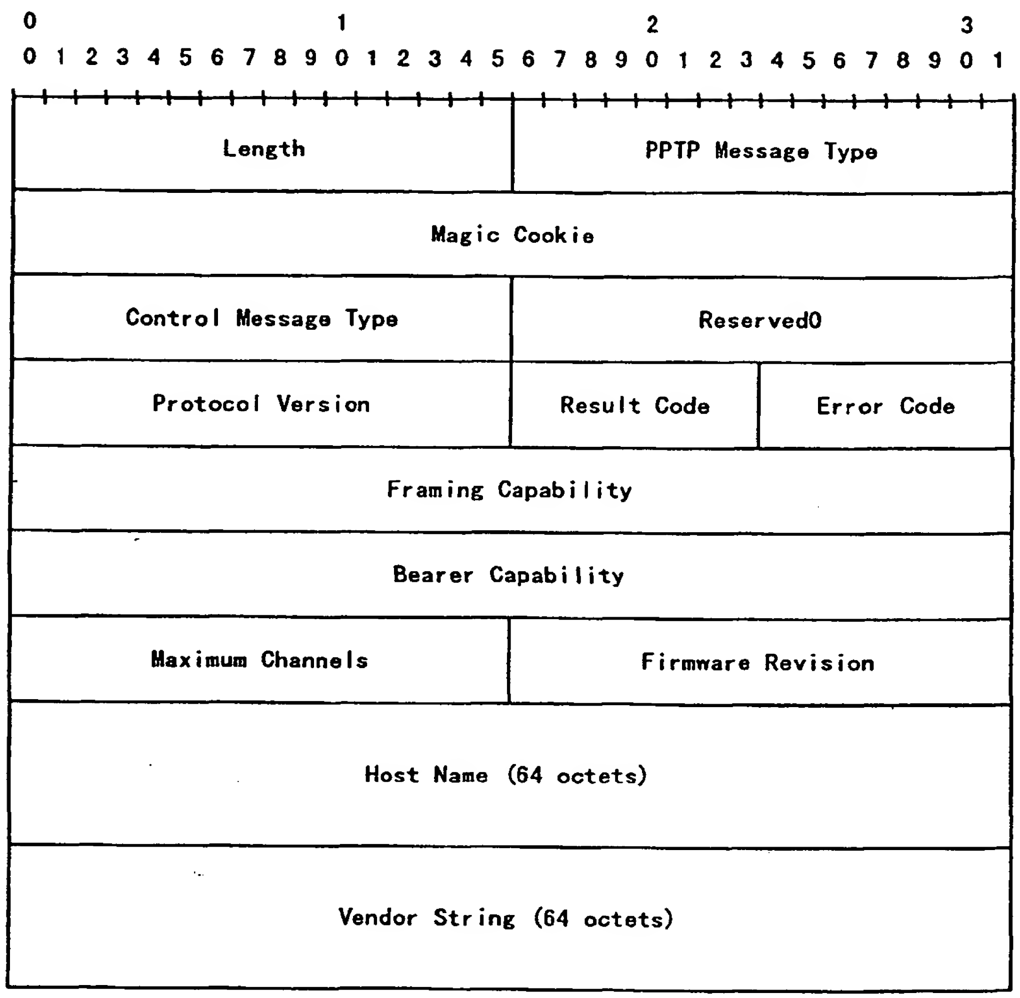

0
1
2
3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Length
PPTP Message Type
Magic Cookie
Control Message Type
Reserved0
Protocol Version
Result Code
Error Code
Framing Capability
Bearer Capability
Maximum Channels
Firmware Revision
Host Name (64 octets)
Vendor String (64 octets)

FIG. 16

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

Length	PPTP Message Type
Magic Cookie	
Control Message Type	Reserved0
Call ID	Call Serial Number
Minimum BPS	
Maximum BPS	
Bearer Type	
Framing Type	
Packet Recv. Window Size	Packet Processing Delay
Phone Number Length	Reserved1
Host Number (64 octets)	
Subaddress (64 octets)	

F I G. 1 8

*	CELL NAME	DIRECTION	CAPABILITY
1	IDLE VC INDICA-TION CELL	Con. Mgr. →SVC Cont	· EXPLICITLY INDICATING TO SVC Cont THAT THE VC IS NOT USED
2	CONNECTION CONFIRM CELL	SVC Cont →Con. Mgr.	· CONFIRMING Con. Mgr. THAT VC IS IDLE WHEN SVC Cont DESIRES TO USE THE VC FOR ITS PORT
3	CONNECTION CONFIRM REPLY CELL	Con. Mgr. →SVC Cont	· USED BY Con. Mgr. IN ORDER TO NOTIFY SVC Cont OF VC STATE · UPON RECEIPT OF THIS CELL, SVC Cont LINKS DROP VC TO FEEDER VC
4	CONNECTION GET CELL	SVC Cont →Con. Mgr.	· USED BY SVC Cont IN ORDER TO NOTIFY Con. Mgr. THAT SVC Cont WHICH CONFIRMED THAT VC IS IDLE HAS OBTAINED CORRESPONDING VC · UPON RECEIPT OF THIS CELL, Con. Mgr. MUST STOP TRANSMISSION OF VC INDICATION CELL FOR CORRESPONDING VC · IF VC INDICATION CELL IS TRANSMITTED EVEN AFTER THIS CELL IS TRANSMITTED, SVC Cont REPEATEDLY TRANSMITS THIS CELL UNTIL TRANSMISSION OF VC INDICATION CELL IS STOPPED · IF INDICATION CELL IS TRANSMITTED THE NUMBER OF TIMES WHICH EXCEEDS THRESHOLD NUMBER SET AT SYSTEM START-UP, SVC Cont EXTERNALLY OUTPUTS THIS FACT AS FAULT INFORMATION
5	CONNECTION GET REPLY ACKNOWLEDGE CELL	Con. Mgr. →SVC Cont	· UPON RECEIPT OF CONNECTION GET CELL, RESPONSE IS MADE WITH THIS CELL IF SVC Cont USES CORRESPONDING VC AS INDICATED BY NOTIFICATION. UPON RECEIPT OF THIS CELL SVC Cont AGAIN SEARCHES NOMINATED VC MAP
6	CONNECTION GET REPLY CELL	Con. Mgr. →SVC Cont	· UPON RECEIPT OF CONNECTION GET CELL, THIS CELL IS USED IN ORDER TO NOTIFY VC Cont TO USE ANOTHER VC

F I G. 2 0

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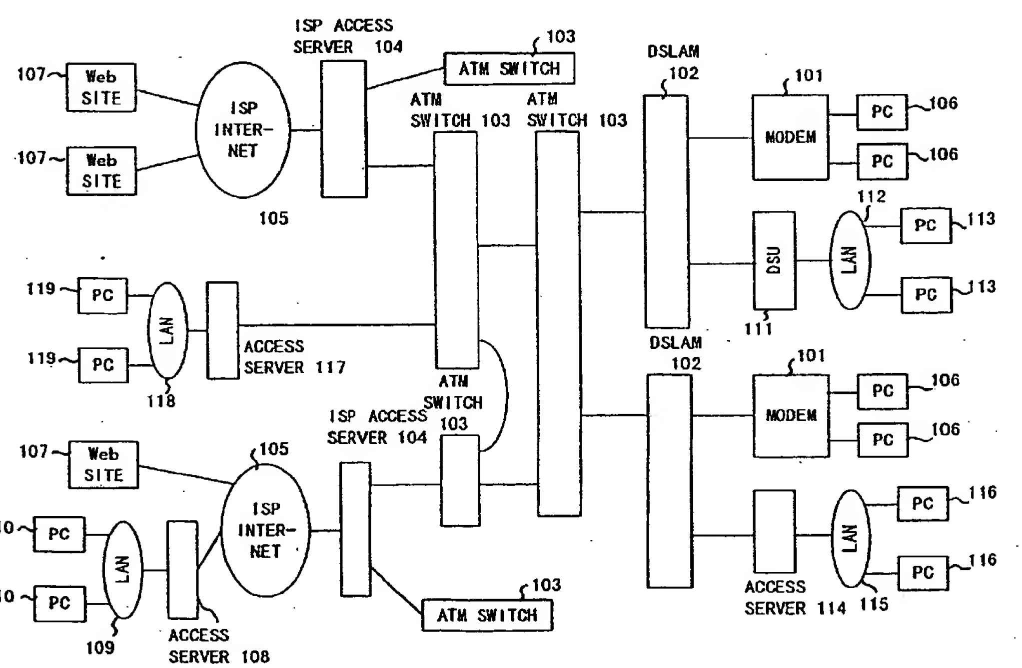
(54) **SVC accessing method for use in ATM-DSLAM (ATM - DSL Access Multiplexer)**

(57) An access server and a DSLAM are continuously connected by a PVC. The access server and the DSLAM manage an unused ATM VC within the PVC while making a communication with an idle VC indication cell which is an OAM cell. The DSLAM allocates the unused ATM VC by communicating with the access server based on a call originating request issued from a modem.



F I G. 2

EP 0 944 281 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 11 9794

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	MADING G: "ATM ISN'T DEAD YET - ADSL COULD BE THE CATALYST FOR DEPLOYMENT" ELECTRONIC DESIGN, HAYDEN PUB. CO., NEW YORK, NY, US, vol. 45, no. 13, 23 June 1997 (1997-06-23), pages 133-134,136, XP000729093 ISSN: 0013-4872	26-30	
A	* the whole document *	1-25	

			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 May 2005	Mariggis, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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